

# Non-Parametric, Closed-Loop Testing of Autonomy in Unmanned Aircraft Systems, Phase II

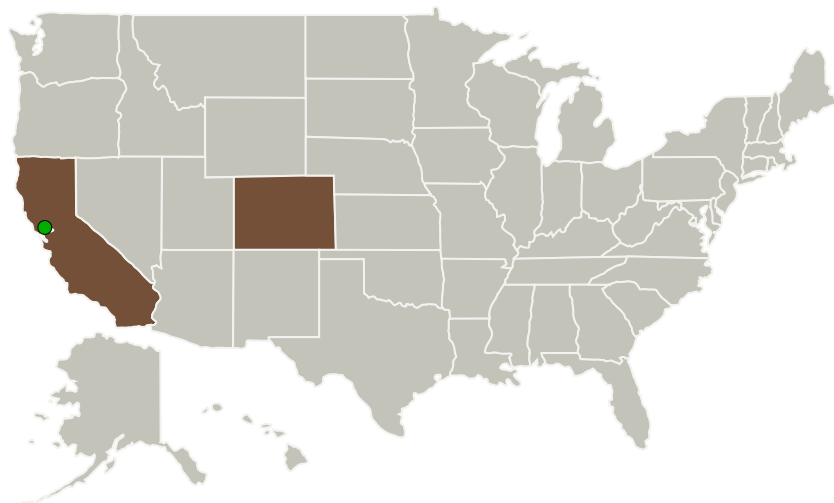
Completed Technology Project (2015 - 2018)



## Project Introduction

The proposed Phase II program aims to develop new methods to support safety testing for integration of Unmanned Aircraft Systems into the National Airspace (NAS) with a particular focus on testing the collision avoidance (CA) algorithms of a UAS Sense-and-Avoid (SAA) system. This research addresses the fundamental difficulty of verifying the performance of autonomous systems that dynamically react to the environment. In particular, this research program would develop novel methods for conducting non-parametric, closed-loop simulation testing of collision avoidance algorithms as well as other autonomous operations. The technology generates a campaign of simulation experiments that automatically adapt to the algorithms in question. The purpose of this innovation is to expose potential vulnerabilities in UAS autonomy that are generated through the interaction of autonomous UAS algorithms with other agents such as an intruding aircraft operating under ``right of way rules". This work augments both the probabilistic open-loop testing methods, where agents do not react, and closed-loop testing where agent behavior is fixed a priori.

## Primary U.S. Work Locations and Key Partners



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Organizations Performing Work	Role	Type	Location
Numerica Corporation	Lead Organization	Industry	Fort Collins, Colorado
● Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California

## Primary U.S. Work Locations

California	Colorado
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## Project Transitions

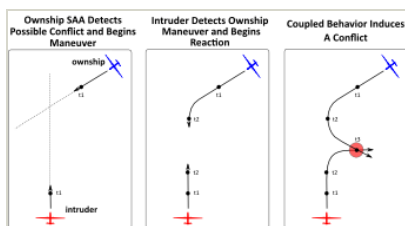
▶ **May 2015:** Project Start

✓ **February 2018:** Closed out

### Closeout Documentation:

- Final Summary Chart(<https://techport.nasa.gov/file/137534>)

## Images



### Briefing Chart

Non-Parametric, Closed-Loop Testing of Autonomy in Unmanned Aircraft Systems Briefing Chart (<https://techport.nasa.gov/image/125946>)

## Organizational Responsibility

### Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

### Lead Organization:

Numerica Corporation

### Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

### Program Director:

Jason L Kessler

### Program Manager:

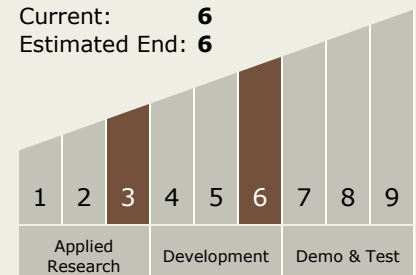
Carlos Torrez

### Principal Investigator:

Joseph Knuth

## Technology Maturity (TRL)

Start: **3**  
Current: **6**  
Estimated End: **6**



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## Technology Areas

### Primary:

- TX11 Software, Modeling, Simulation, and Information Processing
  - └ TX11.1 Software Development, Engineering, and Integrity
    - └ TX11.1.3 Test and Evaluation

## Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System